

Name: _____ Date: _____

Generations of Biofuels Worksheet

Vocabulary Activity:

1. Define in your own words and give examples of the following words:

- a. Biomass:
- b. Biofuel:
- c. Renewable:
- d. 1st generation biofuels:
- e. 2nd generation biofuels:
- f. 3rd generation biofuels:
- g. Sustainable:

2. Match the word with its definition:

- | | |
|------------------------|----------------------------------------------------------------------------|
| a. Ethanol | 1. An alcohol produced through the fermentation of sugars |
| b. Biodiesel | 2. The material in plants that acts as glue and holds things together |
| c. Lignin | 3. A process by which the primary product is separated from any byproducts |
| d. Cellulose | 4. A process that converts sugars into alcohol through the use of enzymes |
| e. Transesterification | 5. A sugar found in plants that is used to produce ethanol |
| f. Distillation | 6. A biofuel produced from animal and vegetable oils |
| g. Fermentation | 7. A process that converts animal and vegetable oils into biodiesel |

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Pro/Cons Activity:

Identify whether the following sentences are advantages or disadvantages of the different generations of biofuels, and what generation of biofuel(s) it is describing

- 1) Burns cleaner than fossil fuels
- 2) Can use waste water and can be grown in the ocean
- 3) Technology still needs improvement to make it competitive with fossil fuels
- 4) Biomass source are food crops such as corn, potatoes and sugar beet
- 5) Produces ethanol, which has a much lower energy density than gasoline
- 6) Competes with food crops over clean water and arable land
- 7) Biomass crops can be grown in land unsuitable for food crops
- 8) Is more energy dense per acre of harvest than the other two generations
- 9) Needs to be treated prior to fermentation to release the 'trapped' sugars
- 10) Provides only a slight advantage with regards to greenhouse gases due to the high energy input required to produce
- 11) The process to produce has been known for centuries and is used to make alcohol, yogurt, vinegar, etc

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Answers:

- 1) Advantage. All three generations of biofuels burn cleaner than fossil fuels. Using biofuels results in substantial reduction of unburned hydrocarbons, carbon monoxide, and particulate matter compared to emissions from fossil fuels.
- 2) Advantage. 3rd generation biofuels are the only ones that do not require clean, fresh water to grow the biomass
- 3) Disadvantage. 2nd and 3rd generation biofuels still need technological improvements. 2nd generation to break down the lignin easier and cheaper and 3rd generation to improve the extraction process and drive down operating costs.
- 4) Disadvantage. 1st generation biofuels are the only ones that use food crops as biomass. This might make food prices lower and ethical questions of what is a better use for these crops.
- 5) Disadvantage. All three generations of biofuels are capable to produce ethanol but it is mainly done with 1st and 2nd generation biofuels. 3rd generation biofuels produce mainly biodiesel which also has a lower energy density than petrodiesel, its fossil fuel equivalent.
- 6) Disadvantage. 1st and 2nd generation biofuels compete with food crops over clean water and arable land.
- 7) Advantage. 2nd generation biomass can be grown in areas of the world where crops do not grow. 3rd generation biofuels can be grown in ocean or in waste water that is unsuitable for food crop use.
- 8) Advantage. 3rd generation biofuels can produce more biofuel per acre harvested than the other two generations.
- 9) Disadvantage. 2nd generation biofuels require that lignin be broken up to release the cellulose and hemicelluloses trapped within it and are fermented to produce fuel. This process requires energy, materials and time therefore it makes it financially disadvantageous over fossil fuels and 1st generation biofuels.
- 10) Disadvantage. 1st and 2nd generation biofuels require a high amount of fossil fuels to fuel the production process.
- 11) Advantage. 1st and 2nd generation biofuels use fermentation to convert sugars into ethanol. This process has been used to make products such as alcohol, vinegar and yogurt.

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